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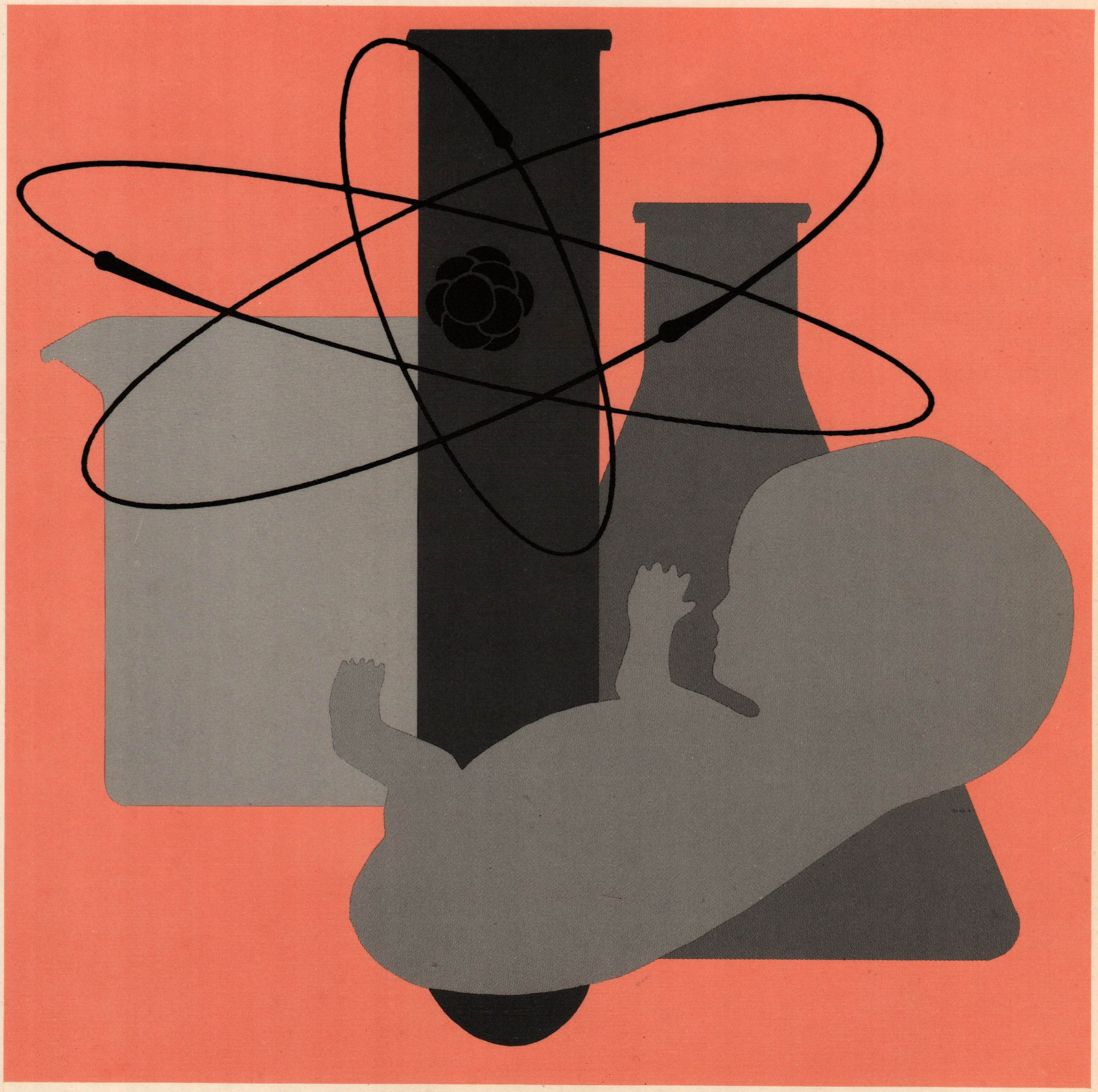
BASIC Application Programs–Science



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DEC EDUCATIONAL PUBLICATIONS

Other publications in the continuing series of curriculum material published by DEC for use with EduSystems 10 through 80 are listed below. Please inquire directly for prices on classroom quantities.

Additional publications may be obtained from:

Program Library
Digital Equipment Corporation
Maynard, Massachusetts 01754

Populution: Self-teaching BASIC Workbook	$2.00
BASIC Application Programs	
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BASIC APPLICATION PROGRAMS

The programs contained in this series are designed to demonstrate how the computer can be applied in a meaningful way to problems of many disciplines. The problems and the corresponding programs are, for the most part, quite simple and are designed to be "jumping off points" for students from the high school level on up.

All of the programs, with very few exceptions, may be run on EduSystems 10 through 80, PDP-8 Family and PDP-11 Family computers. Exceptions are noted in the program descriptions.

DEC welcomes contributions of programs and write-ups for use in this series. Contributors will be credited as program "Source". Please send programs and descriptions to Educational Marketing (5-2).

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SCIENCE

Biology	EVOLU	Demonstrates evolutionary mutations of pepper moths.
Chemistry	GASVOL	Calculates and plots gas volumes at various pressures.
Physics	INDUC	Determines value of an unknown inductor.
	KINEMA	Tests knowledge of kinematics.
	LUNAR, LUNAR2	Simulates the landing of a lunar module on the moon.
	NEWTON	Problems using Newton's second law.
	PHOTOE	Demonstrates photo electric effect.
	RESIST	Computes equivalent resistance for resistor networks.
	UELEC	Produces tables of electric potential.

AREA: Biology **NUMBER:** **NAME:** EVOLU
SOURCE: Huntington Computer Project **LANGUAGE:** BASIC

DESCRIPTION: The EVOLU program demonstrates the effects of genetic mutations of a sample of 10000 pepper moths. These mutations cause a small number of these moths to become somewhat darker in tone. However, it takes many years for this effect to show up, making it impossible to show in a school lab. In addition, the program allows the student to vary the mutation rate and to change the environment midway in the experiment.

```
210 PRINT
215 PRINT "ENTER RATE OF MUTATION (1 TO 10)";
220 INPUT M
250 LET P0=10000
260 LET Z=P0
450 PRINT "YEAR IN WHICH ENVIRONMENTAL CHANGE OCCURS";
460 INPUT X
464 LET L=1
466 LET D=2
470 PRINT "CHANGE FAVORS LIGHT MOTHS OR DARK (ENTER 1 OR 2);
480 INPUT E
580 PRINT
582 PRINT "YEAR","DARK MOTHS","LIGHT MOTHS"
584 PRINT
610 FOR T=1 TO 30
620 IF T>=X THEN 650
630 LET P1=0
640 GO TO 710
650 IF E<>2 THEN 630
660 LET P1=INT(P1+.01*M*P0+.5)
670 LET P0=INT(Z-P1+.5)
680 IF P1<Z THEN 710
690 LET P1=Z
700 LET P0=0
710 PRINT T,P1,P0
720 NEXT T
999 END

READY
```

USAGE: Type RUN. When asked, enter the mutation rate (from 1 to 10), the year in which the environment is to change (3 to 10) and whether the environmental change will favor light (type a 1) or dark ones (type a 2). The program then prints out the course of evolution over a thirty year period.

```
ENTER RATE OF MUTATION (1 TO 10)? 2
YEAR IN WHICH ENVIRONMENTAL CHANGE OCCURS? 3
CHANGE FAVORS LIGHT MOTHS OR DARK (ENTER 1 OR 2)? 2

YEAR             DARK MOTHS     LIGHT MOTHS

 1                0              10000
 2                0              10000
 3                200            9800
 4                396            9604
 5                588            9412
 6                776            9224
 7                960            9040
 8                1141           8859
 9                1318           8682
 10               1492           8508
 11               1662           8338
 12               1829           8171
 13               1992           8008
 14               2152           7848
 15               2309           7691
 16               2463           7537
 17               2614           7386
 18               2762           7238
 19               2907           7093
 20               3049           6951
 21               3188           6812
 22               3324           6676
 23               3458           6542
 24               3589           6411
 25               3717           6283
 26               3843           6157
 27               3966           6034
 28               4087           5913
 29               4205           5795
 30               4321           5679
```

EDUCATIONAL BENEFITS: Where else can a student observe a thirty year reproductive cycle and watch the effects of mutations? More important, where else can the student repeat the cycle, trying new parameters and conditions?

Many other common science experiments take a long time to run, or require the student to run it several times. To get meaningful results, they may often by simulated on the computer.

AREA: Chemistry NUMBER: NAME: GASVOL
SOURCE: NREL/SDC/DEC LANGUAGE: BASIC

DESCRIPTION: The volume of a gas varies directly with the absolute temperature T (Kelvin) and inversely with the pressure P. If a certain quantity of gas occupies 500 cubic feet at a pressure of 53 pounds per square foot and an absolute temperature of 500 degrees, what volume will it occupy at 600 degrees absolute temperature and pressures from 100 to 1000 pounds per square foot in increments of 50 pounds?

The original conditions are used to solve for the constant K in line 10. ($K = VP/T$). Then the new volumes are computed for varying pressures with $T = 600^{o}$ using the formula $V = KT/P$.

In the second part of the program lines 70 - 130 have been added to give a plot of the volume for the various pressures.

How would you modify the program to deal with a more general case (i.e., other gasses and different temperatures)?

```
10 LET K=500*53/500
20 PRINT "A GAS, AT 600 DEGREES KELVIN, AND PRESSURE AS"
25 PRINT "LISTED, OCCUPIES THE VOLUME SPECIFIED."
30 PRINT
40 PRINT "PRESSURE","VOLUME"
50 FOR P=100 TO 1000 STEP 50
60 LET V=K*600/P
70 PRINT P,V
80 NEXT P
99 END
```

B

```
RUN

A GAS, AT 600 DEGREES KELVIN, AND PRESSURE AS
LISTED, OCCUPIES THE VOLUME SPECIFIED.

PRESSURE      VOLUME
 100           318
 150           212
 200           159
 250           127.2
 300           106
 350           90.85714
 400           79.5
 450           70.66667
 500           63.6
 550           57.81818
 600           53
 650           48.92308
 700           45.42857
 750           42.4
 800           39.75
 850           37.41176
 900           35.33333
 950           33.47368
 1000          31.8


READY

  70 PRINT P;
  80 LET X=INT(V*2/10+.5)
  90 FOR L=1 TO X
 100 PRINT " ";
 110 NEXT L
 120 PRINT "X"
 130 NEXT P
 999 END

READY

RUN

A GAS, AT 600 DEGREES KELVIN, AND PRESSURE AS
LISTED, OCCUPIES THE VOLUME SPECIFIED.

PRESSURE      PLOT OF VOLUME
 100                                                                 X
  150                                               X
 200                                     X
 250                              X
 300                          X
 350                       X
 400                     X
 450                   X
 500                  X
 550                 X
 600                X
 650               X
 700              X
 750             X
 800             X
 850            X
 900            X
 950            X
 1000           X
```

C

AREA: Electronics NUMBER: NAME: INDUC
SOURCE: Digital Equipment Corp. LANGUAGE: BASIC

DESCRIPTION: This program combined with the indicated laboratory measurements will determine the value of an unknown inductor, such as a choke or transformer winding.

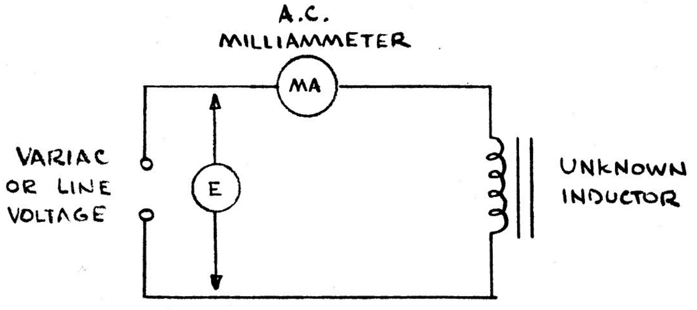
APPROACH: The impedance of an inductor is made up of two quantities; inductive reactance (X_L) and d.c. resistance (R). First, measure the resistance with an ohmmeter.

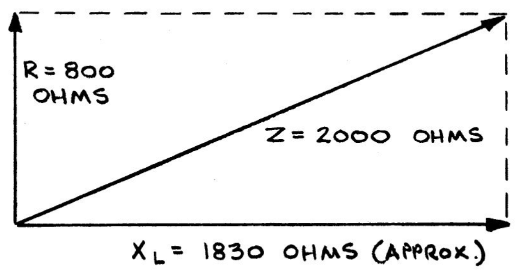
Next, determine the voltage (E) and current (I) of an a.c. circuit where the unknown inductance constitutes the entire load. Ohm's Law may be applied to find the impedance, Z = E/I.

We can now separate R from X_L by means of a vector diagram in which R becomes the base and Z, the hypotenuse. Once X_L has been obtained, the inductance L may be found from the formula:

$$L = \frac{X_L}{2\pi f}$$

In the formula, f is the frequency. A simple computer program can replace the various calculations and vector diagram. The program plus a sample run are shown on the back.





```
  5 PRINT "PROGRAM INDUC"
  6 PRINT
 10 PRINT "TO FIND THE VALUE OF AN UNKNOWN INDUCTOR,"
 11 PRINT "INPUT THE FOLLOWING QUANTITIES:"
 12 PRINT
 15 PRINT "RESISTANCE";
 16 INPUT R
 20 PRINT "VOLTAGE";
 21 INPUT E
 25 PRINT "CURRENT";
 26 INPUT I
 30 PRINT "FREQUENCY";
 31 INPUT Q
 35 LET Z=E/I
 40 LET X=SQR(Z*Z-R*R)
 45 LET L=X/(2*3.14159*Q)
 50 PRINT
 51 PRINT "INDUCTANCE IS"L"HENRIES."
 99 END

READY

RUN

PROGRAM INDUC

TO FIND THE VALUE OF AN UNKNOWN INDUCTOR,
INPUT THE FOLLOWING QUANTITIES:

RESISTANCE? 800
VOLTAGE? 100
CURRENT? .05
FREQUENCY? 60

INDUCTANCE IS 4.862268 HENRIES.


READY

RUN

PROGRAM INDUC

TO FIND THE VALUE OF AN UNKNOWN INDUCTOR,
INPUT THE FOLLOWING QUANTITIES:

RESISTANCE? 400
VOLTAGE? 115
CURRENT? .046
FREQUENCY? 60

INDUCTANCE IS 6.546029 HENRIES.


READY
```

AREA: Physics **NUMBER:** **NAME:** KINEMA
SOURCE: Digital Equipment Corp. **LANGUAGE:** BASIC

DESCRIPTION: The KINEMA program tests the student's knowledge of kinematics. A ball, or any other object, is thrown up at a certain velocity (in meters per second.) The student is then asked to calculate certain information about the resulting trajectory. The computer then checks the response to see if it is within 15% of the correct answer.

```
100 PRINT
105 PRINT
106 LET Q=0
110 LET V=5+INT(35*RND(0))
111 PRINT "A BALL IS THROWN UPWARDS AT"V"METERS PER SECOND"
 112 PRINT
115 LET A=.05*V↑2
116 PRINT "HOW HIGH WILL IT GO (IN METERS)";
117 GOSUB 500
120 LET A=V/5
122 PRINT "HOW LONG UNTIL IT RETURNS (IN SECONDS)";
124 GOSUB 500
130 LET T=1+INT(2*V*RND(1))/10
132 LET A=V-10*T
134 PRINT "WHAT WILL ITS VELOCITY BE AFTER"T"SECONDS";
136 GOSUB 500
140 PRINT
150 PRINT Q"RIGHT OUT OF 3.";
160 IF Q<2 THEN 100
170 PRINT "  NOT BAD."
180 GO TO 100
500 INPUT G
502 IF ABS((G-A)/A)<.15 THEN 510
504 PRINT "NOT EVEN CLOSE...."
506 GO TO 512
510 PRINT "CLOSE ENOUGH."
511 LET Q=Q+1
512 PRINT "CORRECT ANSWER IS"A
520 PRINT
530 RETURN
999 END

READY
```

USAGE: Load KINEMA, then type RUN. Then try to answer the questions. Distances should be entered in meters, time in seconds, and velocity in meters per second (plus for up, minus for down.)

```
RUN


A BALL IS THROWN UPWARDS AT 13 METERS PER SECOND

HOW HIGH WILL IT GO (IN METERS)? 8
CLOSE ENOUGH.
CORRECT ANSWER IS 8.45

HOW LONG UNTIL IT RETURNS (IN SECONDS)? 3
NOT EVEN CLOSE....
CORRECT ANSWER IS 2.6

WHAT WILL ITS VELOCITY BE AFTER 1.7 SECONDS? -4
CLOSE ENOUGH.
CORRECT ANSWER IS-4


 2 RIGHT OUT OF 3.  NOT BAD.


A BALL IS THROWN UPWARDS AT 30 METERS PER SECOND

HOW HIGH WILL IT GO (IN METERS)? 50
CLOSE ENOUGH.
CORRECT ANSWER IS 45

HOW LONG UNTIL IT RETURNS (IN SECONDS)? 6
CLOSE ENOUGH.
CORRECT ANSWER IS 6

WHAT WILL ITS VELOCITY BE AFTER 2.8 SECONDS? 4
NOT EVEN CLOSE....
CORRECT ANSWER IS 2


 2 RIGHT OUT OF 3.  NOT BAD.
```

EDUCATIONAL BENEFIT: The key educational benefit here is the powerful motivating force that the computer has. The work that the student is being asked to do is really no different than rote homework exercises. But the computer makes it a challenge. It is very frustrating to have a dumb computer keep telling you you're wrong. Try it yourself and see if it doesn't make you want to brush up on your physics. That's real motivation.

4K RAM

AREA: Games/Physics NUMBER: NAME: LUNAR
SOURCE: Digital Equipment Corp. LANGUAGE: BASIC

DESCRIPTION: The program represents an exact simulation of an Apollo lunar landing module during the final descent. This portion of the descent would normally be controlled by the on-board computer backed up by a computer located on Earth. However, to exercise your knowledge of physics (and make an interesting game), both computers simultaneously have had a malfunction; therefore, you are on your own to safely land the spacecraft.

To make a soft landing, you may reset the burn rate of the retro rockets every ten seconds. You have a choice of not firing at all (burn rate=0) or firing at a rate between 8 and 200 lbs. per second. You have 16500 lbs. of fuel. If the rockets were not fired, your estimated free fall impact time is 120 seconds. The capsule weight is 33,000 pounds

USAGE: This program runs on EduSystem 20 and larger systems. Type SCR to get rid of any existing programs and load LUNAR. Type RUN to commence landing procedure. When a "?" is typed under burn rate, enter your burn rate and hit the return key. Remember, the only acceptable burn rates are 0 or any number between 8 and 200.

After you're down and the computer has typed "READY", if you wish to try it again, simply type RUN. Good luck!

```
RUN
GROUND CONTROL CALLING LUNAR MODULE.....
ON-BOARD AND GROUND COMPUTERS HAVE SIMULTANEOUSLY
MALFUNCTIONED  (THEY WEREN'T DEC MACHINES)
MANUAL CONTROL IS NECESSARY.

CAPSULE WEIGHT 32,500 LBS    AVAILABLE FUEL 16,500 LBS
ESTIMATED FREE FALL IMPACT TIME 120 SECONDS

SET RETRO ROCKET BURN RATE EVERY 10 SECONDS TO ANY VALUE
BETWEEN 0 LBS/SEC (FREE FALL) AND
200 LBS/SEC (STRONG BRAKING)

GOOD LUCK   !!!

SEC           MI + FT         MPH           LB FUEL        BURN RATE

 0             120  0          3600          16500          ? 0
 10            109  5016       3636          16500          ? 0
 20            99   4224       3672          16500          ? 0
 30            89   2904       3708          16500          ? 0
 40            79   1056       3744          16500          ? 0
 50            68   3960       3780          16500          ? 0
 60            58   1056       3816          16500          ? 0
 70            47   2904       3852          16500          ? 200
 80            37   1884       3482.868      14500          ? 200
 90            28   1191       3086.708      12500          ? 200
 100           20   1251       2659.654      10500          ? 200
 110           13   2549       2196.947      8500           ? 200
 120           8   370         1692.634      6500           ? 200
 130           4   658         1139.138      4500           ? 200
 140           1   4204        526.5976      2500           ? 100
 150           0   4042        212.242       1500           ? 45
 160           0   1864        84.18261      1050           ? 20
 170           0   909         45.91246      850            ? 17
 180           0   438         18.10655      680            ? 13
 190           0   269         4.886334      550            ? 10
 200           0   213         2.768577      450            ? 10
 210           0   189         .4252701      350            ? 9.2
 220           0   179         .9479145      258            ? 9.3
 230           0   165         .8864265      165            ? 9.4
 240           0   157         .2320987      71             ? 7.1
RAN OUT OF FUEL AT 250 SEC
ON THE MOON AT 254.0616 SEC - IMPACT VELOCITY 23.03008 MPH
CRAFT DAMAGE.  YOU'RE STRANDED HERE UNTIL A RESCUE MISSION
ARRIVES.  HOPE YOUR OXYGEN HOLDS OUT!

READY
```

```
READY

TAPE

     1 PRI "GROUND CONTROL CALLING LUNAR MODULE....."
     2 PRI "ON-BOARD AND GROUND COMPUTERS HAVE SIMULTANEOUSLY"
     3 PRI "MALFUNCTIONED  (THEY WEREN'T DEC MACHINES)"
     4 PRI "MANUAL CONTROL IS NECESSARY."
     5 PRI
     6 PRI "CAPSULE WEIGHT 32,500 LBS    AVAILABLE FUEL 16,500 LBS"
     7 PRI "ESTIMATED FREE FALL IMPACT TIME 120 SECONDS"
     8 PRI
     9 PRI "SET RETRO ROCKET BURN RATE EVERY 10 SECONDS TO ANY VALUE"
    10 PRI "BETWEEN 0 LBS/SEC (FREE FALL) AND"
    11 PRI "200 LBS/SEC (STRONG BRAKING)"
    12 PRI
    13 PRI "GOOD LUCK   !!!"
    14 PRI
    15 PRI "SEC","MI + FT","MPH","LB FUEL","BURN RATE"
10  16 PRI
20  20 A=120
25  21 V=1
30  22 M=33000
35  23 N=16500
40  24 G=.001
45  25 Z=1.8
50  30 PRI L,INT(A);INT(5280*(A-INT(A))),3600*V,M-N,
55  31 INPUT K
60  32 T=10
65  40 IF M-N<.001 THEN 70
70  41 IF T<.001 THEN 30
75  42 S=T
80  43 IF M>=N+S*K THEN 50
85  44 S=(M-N)/K
90  50 GOSUB 170
95  51 IF I<=0 THEN 130
100 52 IF V<=0 THEN 60
105 53 IF J<0 THEN 150
110 60 GOSUB 120
115 61 GOTO 40
120 70 PRINT "RAN OUT OF FUEL AT"L"SEC"
125 71 S=(-V+SQR(V*V+2*A*G))/G
130 72 V=V+G*S
135 73 L=L+S
140 80 W=3600*V
145 81 PRINT "ON THE MOON AT"L"SEC - IMPACT VELOCITY"W"MPH"
150 82 IF W>1.2 THEN 90
155 83 PRI "PERFECT LANDING!  (LUCKY)"
160 84 STOP
165 90 IF W>10 THEN 100
170 91 PRI "GOOD LANDING  (COULD BE BETTER)"
175 92 STOP
180 100 IF W>60 THEN 110
185 101 PRI "CRAFT DAMAGE.  YOU'RE STRANDED HERE UNTIL A RESCUE MISSION"
190 102 PRI "ARRIVES.  HOPE YOUR OXYGEN HOLDS OUT!"
195 103 STOP
200 110 PRI "SORRY, BUT THERE WERE NO SURVIVORS -- YOU BLEW IT."
205 111 PRI "IN FACT, YOU BLASTED A NEW LUNAR CRATER"W*.2777"FT DEEP"
210 112 STOP
```

```
215 120 L=L+S
220 121 T=T-S
225 122 M=M-S*K
230 123 A=I
235 124 V=J
240 125 RET
245 130 IF S<.005 THEN 80
250 131 D=V+SQR(V*V+2*A*(G-Z*K/M))
255 132 S=2*A/D
260 140 GOS 170
265 141 GOS 120
270 142 GOTO 130
275 150 W=(1-M*G/(Z*K))/2
280 151 S=M*V/(Z*K*(W+SQR(W*W+V/Z)))+.05
285 152 GOS 170
290 160 IF I<=0 THEN 130
295 161 GOS 120
300 162 IF J>0 THEN 40
305 163 IF V>0 THEN 150
310 164 GOTO 40
315 170 Q=S*K/M
320 171 J=V+G*S-Z*Q*(1+Q*(.5+Q*(1/3+Q*(.25+Q/5))))
325 180 I=A-G*S*S/2-V*S+Z*S*Q*(.5+Q*(1/6+Q*(1/12+Q/20)))
330 181 RET
    200 END

  READY
```

AREA: Games/Physics **NUMBER:** **NAME:** LUNAR2
SOURCE: Digital Equipment Corp. **LANGUAGE:** BASIC (EduSystem 10 only)

DESCRIPTION: This program is a compressed version of the lunar module landing program originally written in 8K FOCAL. The program is also known as LUNAR, ROCKES, and ROCKET.

The program represents an exact simulation of an Apollo lunar landing module during the final descent. This portion of the descent would normally be controlled by the on-board computer backed up by a computer located on Earth. However, to exercise your knowledge of physics (and make an interesting game), both computers simultaneously have had a malfunction; therefore, you are on your own to safely land the spacecraft.

To make a soft landing, you may reset the burn rate of the retro rockets every ten seconds. You have a choice of not firing at all (burn rate=0) or firing at a rate between 8 and 200 lbs. per second. You have 16500 lbs. of fuel. If the rockets were not fired, your estimated free fall impact time is 120 seconds. The capsule weight is 33,000 pounds.

USAGE: This program runs on EduSystem 10 (4K) BASIC only. Retain only the SQR and RND functions (Option F). Type SCR to get rid of any existing programs and load LUNAR2. Type RUN to commence landing procedure. When a "?" is typed under burn rate, enter your burn rate and hit the return key. Remember, the only acceptable burn rates are 0 or any number between 8 and 200.

After you're down and the computer has typed "READY", if you wish to try it again, simply type RUN. Good luck!

```
LIST

13 PRINT "SEC","MI + FT","MPH","LB FUEL","BURN RATE"\PRINT
15 A=120\V=1\M=33000\N=16500\G=1.000000E-03\Z=1.8
21 PRINT L,INT(A);INT(5280*(A-INT(A))),3600*V,M-N,\INPUT K\T=10\PRINT
31 IF M-N<.001 THEN 41\IF T<.001 THEN 21\S=T\IF M<N+S*K THEN S=(M-N)/K
35 GOSUB 91 \IF I<=0 THEN 71 \IF V<=0 THEN 38 \IF J<0 THEN 81
38 GOSUB 61 \GO TO 31
41 PRINT "FUEL OUT AT";L;"SEC"\S=(-V+SQR(V*V+2*A*G))/G\V=V+G*S\L=L+S
51 W=3600*V\PRINT "ON MOON AT";L;"SEC - IMPACT VELOCITY";W;"MPH"
53 IF W>10 THEN 56 \PRINT "GOOD LANDING"\STOP
56 IF W>60 THEN 58 \PRINT "BAD JOLT"\STOP
58 PRINT "NO SURVIVORS-BLASTED NEW LUNAR CRATER"W*.2777;"FT DEEP"\STOP
61 L=L+S\T=T-S\M=M-S*K\A=I\V=J\RETURN
71 IF S<5.000000E-03 THEN 51 \D=V+SQR(V*V+2*A*(G-Z*K/M))\S=2*A/D
73 GOSUB 91 \GOSUB 61 \GO TO 71
81 W=(1-M*G/(Z*K))/2\S=M*V/(Z*K*(W+SQR(W*W+V/Z)))+.05\GOSUB 91
83 IF I<=0 THEN 71 \GOSUB 61 \IF J>0 THEN 31 \IF V>0 THEN 81 \GO TO 31
91 Q=S*K/M\J=V+G*S+Z*(-Q-Q*Q/2-Q↑3/3-Q↑4/4-Q↑5/5)
94 I=A-G*S*S/2-V*S+Z*S*(Q/2+Q↑2/6+Q↑3/12+Q↑4/20+Q↑5/30)\RETURN
99 END
```

```
RUN
SEC           MI + FT       MPH           LB FUEL       BURN RATE

 0             120  0        3600          16500         ?0

 10            109  5016     3636          16500         ?0

 20            99  4224      3672          16500         ?0

 30            89  2904      3708          16500         ?0

 40            79  1056      3744          16500         ?0

 50            68  3960      3780          16500         ?0

 60            58  1056      3816          16500         ?200

 70            48  564       3446.868      14500         ?200

 80            39  399       3050.708      12500         ?200

 90            31  987       2623.654      10500         ?0

 100           23  4483      2659.654      10500         ?200

 110           17  501       2196.947      8500          ?0

 120           10  4975      2232.947      8500          ?200

 130           5  2268       1728.634      6500          ?200

 140           1  2028       1175.137      4500          ?200

ON MOON AT 144.8262 SEC - IMPACT VELOCITY 887.6062 MPH
NO SURVIVORS-BLASTED NEW LUNAR CRATER 246.4883 FT DEEP

READY.
```

AREA: Physics NUMBER: NAME: NEWTON
SOURCE: Project SOLO, Pittsburgh, Pa. LANGUAGE: BASIC

DESCRIPTION: (This problem assumes the student has basic knowledge of Newton's three laws)

The first problem we will solve is as follows:
A car at rest at a traffic light weighs 5.63×10^3 newtons.

(a) What is the mass of the car?

When the light changes to green, it accelerates at 3.18 m/sec^2.

(b) If friction is negligible, what must be the force between the rear wheels and the road?

(c) What is the velocity of the car when it has moved 30 meters?

Remembering that gravitational force is 9.8 m/sec^2 and W=MA, we can calculate the mass of the car directly in statement 20. We can then make use of the relationships:

$$F = MA$$
$$V = V_o + A * T \text{ or } = V_o + 2 * A * D$$

```
 5 PRINT "INPUT W, A, D";
10 INPUT W,A,D
20 LET M=W/9.8
30 LET F=M*A
40 LET V=2*A*D
50 PRINT "M="M,"F="F,"V="V
99 END

READY

RUN

INPUT W, A, D? 5.63E3, 3.18, 30
M= 574.4898    F= 1826.878    V= 190.8
```

If some other force in addition to the gravitational force acts on a falling body, it's acceleration will not be 9.8 m/sec^2. Consider the following problem: The Saturn V rocket has a mass of 3.18×10^6kg. The thrust of its first stage engines is quoted as being 7.5×10^6lbs. What is the initial acceleration of the rocket as it blasts off for the moon.

In this case, Newton's second law is expressed:

$$(F + W) = MA$$

Since the direction of rocket acceleration is upward, W has a negative value.

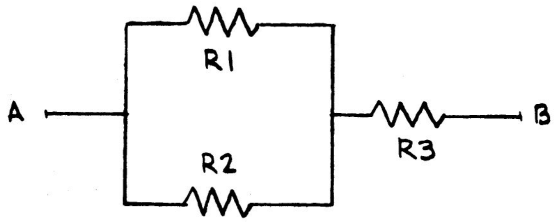
```
5 PRINT "INPUT M, F";
10 INPUT M,F
20 LET W=-M*9.8
30 LET A=(F+W)/M
40 PRINT "ACCEL ="A
99 END

RUN

INPUT M, F? 3.18E6, 3.34E7
ACCEL = .7031447
```

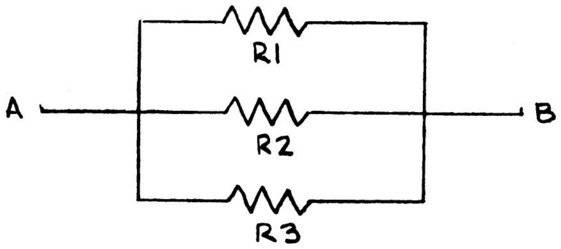
FOR MORE INFORMATION: The teaching module "Newton's Laws of Motion" containing six additional excellent problems is available complete from:

Dr. Thomas Dwyer
Project SOLO, Computation Center
University of Pittsburgh
Pittsburgh, Pa. 15213

AREA: Electricity **NUMBER:** 8-601 **NAME:** Resist
SOURCE: Computer Methods in Mathematics **LANGUAGE:** BASIC

DESCRIPTION: The problem is to computer the equivalent resistance between points A and B for the circuits below:





APPROACH: We must remember that in series, resistance is additive, that is:

$$R_T = R_1 + R_2 \text{ ---}$$

Whereas in parallel, the resultant resistance is computed as follows:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \text{ ---}$$

Given these relationships, it is a simple matter to write a program to compute the resultant resistance for the two circuits above.

```
 5 PRINT "PROGRAM RESIST"
 6 PRINT
10 PRINT "R1";
15 INPUT R1
20 PRINT "R2";
25 INPUT R2
30 PRINT "R3";
35 INPUT R3
40 LET R4=1/(1/R1+1/R2)+R3
50 PRINT
60 PRINT "R4 =";R4
99 END
```

```
RUN

PROGRAM RESIST

R1? 330
R2? 220
R3? 110

R4 = 242


READY

RUN

PROGRAM RESIST

R1? 10
R2? 10
R3? 10

R4 = 15


READY
```

For the second circuit, we need change only one statement in our program:

```
40 LET R4=1/(1/R1+1/R2+1/R3)

RUN

PROGRAM RESIST

R1? 330
R2? 220
R3? 110

R4 = 60


READY

RUN

PROGRAM RESIST

R1? 10
R2? 10
R3? 10

R4 = 3.333333


READY
```

EDUCATIONAL BENEFITS: The computer can be used as a tool to aid in solving all kinds of practical problems. It is not necessary for a student to get bogged down in mathematical calculations when he is eagerly learning about other things.

```
RUN

PROGRAM UELEC

WHAT IS THE VALUE OF Q(1)? 10
WHAT IS THE VALUE OF Q(2)? 1

WHAT ARE THE DISTANCE LIMITS, R(1), R(2), BETWEEN
WHICH YOU DESIRE THE VALUES TO RUN? 1,2
HOW MANY SUBDIVISIONS OF THE INTERVAL DO YOU WISH? 12

DISTANCE, R   ELECTRIC POTENTIAL, U
   METERS             JOULES

    1                8.988000E+10
    1.083333         8.296615E+10
    1.166667         7.704000E+10
    1.25             7.190400E+10
    1.333333         6.741000E+10
    1.416667         6.344471E+10
    1.5              5.992000E+10
    1.583333         5.676632E+10
    1.666667         5.392800E+10
    1.75             5.136000E+10
    1.833333         4.902546E+10
    1.916667         4.689391E+10
    2                4.494000E+10


READY

RUN

PROGRAM UELEC

WHAT IS THE VALUE OF Q(1)? 10
WHAT IS THE VALUE OF Q(2)? 5

WHAT ARE THE DISTANCE LIMITS, R(1), R(2), BETWEEN
WHICH YOU DESIRE THE VALUES TO RUN? -
MORE? .5,5
HOW MANY SUBDIVISIONS OF THE INTERVAL DO YOU WISH? 9

DISTANCE, R   ELECTRIC POTENTIAL, U
   METERS             JOULES

    .5               8.988000E+11
    1                4.494000E+11
    1.5              2.996000E+11
    2                2.247000E+11
    2.5              1.797600E+11
    3                1.498000E+11
    3.5              1.284000E+11
    4                1.123500E+11
    4.5              9.986667E+10
    5                8.988000E+10


READY
```

AREA: Physics/Electricity NUMBER: NAME: UELEC
SOURCE: J. Martin, Rutland High School LANGUAGE: BASIC

DESCRIPTION: This is a program which produces a table of values for the electric potential energy, in joules, at various separations, in meters (R), of two electric charges, Q1 and Q2.

$$U_{elec} = (K*Q1*Q2)/R$$

The user inputs the values of Q1, Q2, R1, R2 <u>and</u> the number of subdivisions desired in the total interval of distance R2-R1. Note that R1 must be less than R2.

```
  5 PRINT "PROGRAM UELEC"
  6 PRINT
100 PRINT "WHAT IS THE VALUE OF Q(1)";
110 INPUT Q1
120 PRINT "WHAT IS THE VALUE OF Q(2)";
130 INPUT Q2
140 PRINT
150 LET K=8.988 E9
160 PRINT "WHAT ARE THE DISTANCE LIMITS, R(1), R(2), BETWEEN"
 170 PRINT "WHICH YOU DESIRE THE VALUES TO RUN";
180 INPUT R1,R2
190 PRINT "HOW MANY SUBDIVISIONS OF THE INTERVAL DO YOU WISH";
200 INPUT S
205 PRINT
210 PRINT "DISTANCE, R","ELECTRIC POTENTIAL, U"
215 PRINT "   METERS","      JOULES"
216 PRINT
220 FOR R=R1 TO R2 STEP (R2-R1)/S
225 LET U=K*Q1*Q2/R
230 PRINT "   ";R,"    ";U
250 NEXT R
999 END

READY
```

AREA: Physics NUMBER: NAME: PHOTOE
SOURCE: Huntington Computer Project LANGUAGE: BASIC

DESCRIPTION: When light of short wave-length falls on a metal surface, electrons are ejected from the metal. According to the description of this phenomenon by Einstein, there is a maximum wavelength for each metal above which no electrons are emitted. This program lets the user find this critical wave-length.

APPROACH: The program simulates the actual experiment, where the metal is placed in a vacuum and bombarded with soft X-rays. The number of electrons ejected is collected and counted by means of an ammeter. The program types out three ammeter readings for each wave-length. After this has been done, the intensity may be increased and the experiment rerun. The typed out values coule then be graphed to show the critical wave-length.

To pick a metal enter its coefficient as follows:

Silver	.308
Bismuth	.338
Cadmium	.318
Lead	.340
Platinum	.385

EDUCATIONAL BENEFITS: Students very rarely get to work with the same concepts that Einstein worked with, or indeed with any of the great 20th century work in physics. The reason is simple: modern physics uses laboratory gear that is way beyond the means of most schools. The concepts themselves are often easy enough for the student; it is only the lack of equipment that holds him down. As this program demonstrates, the computer can fill this gap by simulating equipment. And unlike most lab equipment which is used with one unit, then lies idle the rest of the term, a computer does all kinds of things all year long. Its flexibility means it is never idle.

```
 100 PRINT
 110 PRINT "ENTER CO-EFFICIENT FOR METAL";
 120 INPUT V0
 460 LET K=INT(1+2*RND(X))
 470 PRINT
 480 PRINT " ","MEASURED CURRENT (MICRO-AMPERES)"
 490 PRINT "WAVELENGHTH","TRIAL 1","TRIAL 2","TRIAL 3"
 500 FOR L=.42 TO .25 STEP -.02
 510 LET M=INT(1000/L)
 520 PRINT M,
 530 FOR J=1 TO 3
 540 IF L>V0 THEN 570
 550 LET I=SQR(INT(25*RND(X)))
 560 GO TO 580
 570 LET I=SQR(K*K*100+INT(35*RND(X)))
 580 LET N=INT(10*I+.5)/10
 590 PRINT N,
 600 NEXT J
 610 PRINT
 620 NEXT L
 625 PRINT
 630 PRINT "INCREASE LIGHT INTENSITY (1 FOR YES, 2 FOR NO)";
  660 INPUT Q2
 670 IF Q2=2 THEN 999
 690 PRINT "BY WHAT FACTOR (1 TO 10)";
 700 INPUT F
 720 LET K=K*F
 730 GO TO 470
 999 END

READY

RUN


ENTER CO-EFFICIENT FOR METAL? .340

                MEASURED CURRENT (MICRO-AMPERES)
WAVELENGHTH     TRIAL 1        TRIAL 2        TRIAL 3
 2380            10.5           11.2           10.5
 2500            10.5           10             10.8
 2631            10.8           10.8           10
 2777            10.4           10.5           10.3
 2941            4.7            2.4            4.9
 3125            2.4            0              4.6
 3333            4.8            4.5            2.6
 3571            3.3            3.3            2.2
 3846            4.4            4              4.4

INCREASE LIGHT INTENSITY (1 FOR YES, 2 FOR NO)? 1
BY WHAT FACTOR (1 TO 10)? 5

                MEASURED CURRENT (MICRO-AMPERES)
WAVELENGHTH     TRIAL 1        TRIAL 2        TRIAL 3
 2380            50             50.1           50.2
 2500            50.2           50.2           50.2
 2631            50.2           50.2           50.3
 2777            50.2           50.2           50.3
 2941            4.8            3.7            1.4
 3125            3.2            3.7            3.7
 3333            2              1.4            4.6
 3571            1.7            3              4.2
 3846            2.8            1              4.1

INCREASE LIGHT INTENSITY (1 FOR YES, 2 FOR NO)? 2
```

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